

Evaluation of the Effect of Lactose Derived Monosaccharide on Galactooligosaccharides Production by β -Galactosidase

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Abstract : Numerous benefits of galactooligosaccharides (GOS) as prebiotics have motivated the study of enzymatic processes for their production. These processes have special complexities due to several factors that make difficult high productivity, such as enzyme type, reaction medium pH, substrate concentrations and presence of inhibitors, among others. In the present work the production of galactooligosaccharides (with different degrees of polymerization: two, three and four) from lactose was studied. The study considers the formulation of a mathematical model that predicts the production of GOS from lactose using the enzyme β -galactosidase. The effect of pH in the reaction was studied. For that, phosphate buffer was used and with this was evaluated three pH values (6.0, 6.5 and 7.0). Thus it was observed that at pH 6.0 the enzymatic activity is insignificant. On the other hand, at pH 7.0 the enzymatic activity was approximately 27 times greater than at 6.5. The last result differs from previously reported results. Therefore, pH 7.0 was chosen as working pH. Additionally, the enzyme concentration was analyzed, which allowed observing that the effect of the concentration depends on the pH and the concentration was set for the following studies in 0.272 mM. Afterwards, experiments were performed varying the lactose concentration to evaluate its effects on the process and to generate the data for the adjustment of the mathematical model parameters. The mathematical model considers the reactions of lactose hydrolysis and transgalactosylation for the production of disaccharides and trisaccharides, with their inverse reactions. The production of tetrasaccharides was negligible and, because of that, it was not included in the model. The reaction was monitored by HPLC and for the quantitative analysis of the experimental data the Matlab programming language was used, including solvers for differential equations systems integration (ode15s) and nonlinear problems optimization (fminunc). The results confirm that the transgalactosylation and hydrolysis reactions are reversible, additionally inhibition by glucose and galactose is observed on the production of GOS. In relation to the production process of galactooligosaccharides, the results show that it is necessary to have high initial concentrations of lactose considering that favors the transgalactosylation reaction, while low concentrations favor hydrolysis reactions.

Keywords : β -galactosidase, galactooligosaccharides, inhibition, lactose, Matlab, modeling

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